"The simplest natural objects have bearings which calculation does not touch, and appearances and relations which definition fails to include."

General Specifications

FOR

Steel Roofs and Buildings.

FOURTH REVISED EDITION.

With Tables.

1901

CHARLES EVAN FOWLER,

M. Am. Soc. C. E.

GENERAL SPECIFICATIONS FOR STEEL ROOFS AND BUILDINGS.

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1899.

GENERAL DESCRIPTION.

1. The structure shall be of the general outline and dimensions shown on the attached diagram, which gives the principal dimensions and all the principal data. (2, 72.) Diagram.

2. The sizes and sections of all members, together with the strains which come upon them, shall be marked in their proper places upon a strain sheet, and submitted with proposal. (1, 72.)

3. The height of the building shall mean the distance from top of masonry to under side of bottom chord of truss. The width and length of building shall mean the extreme distance out to out of framing or sheeting. Clearances.

4. The pitch of roof shall generally be one fourth. (6.)

LOADS.

The trusses shall be figured to carry the following loads:

5. SNOW LOADS. Snow Load.

LOCATION.	PITCH OF ROOF. 1-2	1-3	1-4	1-5	1-6
Southern States and Pacific Slope .	0	0	0	0	0
Central States	0	7	15	22	30
Rocky Mountain States	0	10	20	27	35
New England States	0	10	20	35	45
Northwest States	0	12	25	37	50

Pounds per hor. sq. foot.

6. The wind pressure on trusses in pounds per square foot shall be taken from the following table: Wind Load.

Pitch	Vertical	Horizontal	Normal.
$1\text{-}2 = 45°00'$	19	19	27
$1\text{-}3 = 33°41'$	17	12	22
$1\text{-}4 = 26°34'$	15	8	18
$1\text{-}5 = 21°48'$	13	6	15
$1\text{-}6 = 18°26'$	11	4	13

(7.)

7. The sides and ends of buildings shall be figured for a uniformly distributed wind load of 20 pounds per square foot of exposed surface when 20 feet or less to the eaves; 30 pounds per square foot of exposed surface when 60 feet to the eaves, and proportionately for intermediate heights. (6.)

Weight of covering

8. The weight of covering may be taken as follows: Corrugated iron laid, black and painted, per square foot:

No.	27	26	24	22	20	18	16
	.90	1.00	1.30	1.60	1.90	2.60	3.30 pounds.

For galvanized iron add 0.2 pounds per square foot to above figures.

Slate shall be taken at a weight of 7 pounds per square foot for 3-16″ slate 6″ x 12″, and 8.25 pounds per square foot for 3-16″ slate 12″x 24″, and proportionately for other sizes.

Sheeting of dry pine boards at three pounds per foot board measure.

Plastered ceiling hung below at not less than 10 pounds per square foot.

The exact weight of purlins shall be calculated.

Weight of Trusses

9. The weight of Fink roof trusses up to 200 feet span may be calculated by the following formulæ for preliminary value.

$w = .06\, s + .6$, for heavy loads.

$w = .04\, s + .4$, for light loads. (40, 45.)

s=span in feet. w=weight per hor. sq. ft. in pounds.

Increase of Loads.

10. Mill buildings, or any that are subject to corrosive action of gases, shall have all the above loads increased 25 per cent.

11. Buildings or parts of buildings subject to strains from machinery or other loads not mentioned, shall have the proper allowance made.

Minimum Load.

12. No roof shall, however, be calculated for a less load than 30 pounds per horizontal square foot.

UNIT STRAINS.

		Iron.	Soft-Medium. Steel	
Tension only. 13.	Shapes, net section		15000	(57)
	Bars	14000	17000	
	Bottom flanges of rolled beams		15000	
	Laterals of angles, net section .		20000	(57)
	Laterals of bar	18000		(41)

Compression only.

14. Flat ends and fixed ends . . . , . . $12500 - 500 \dfrac{l}{r}$

l=length in feet c. to c. of connections.

r=least radius of gyration in inches. (59)

Flanges.

15. Top flanges of built girders shall have the same gross area as tension flanges. (24)

Combined.

16. Members subject to transverse loading in addition to direct strain, such as rafters, and posts having knee braces connected to them, shall be considered as fixed at the ends in rivited work, and shall be proportioned by the following formulæ, and the unit strain in extreme fibre shall not exceed for soft medium steel: 15000

$$S = \frac{Mn}{I} + \frac{P}{A} \qquad (52, 62.)$$

S = Strain per square inch in extreme fibre.

M = Moment of transverse force in inch pounds.

n = Distance center of gravity to top or bottom of final section in inches.

I = Final moment of inertia.

P = Direct load.

A = Final area.

		Soft Steel.	Soft-Medium Steel.		
17.	Pins and rivets	10000		(57)	Shearing.
	Web plates		7000		
18.	On dia. of pins and rivet holes	20000	20000	(57)	Bearing.
19.	Extreme fibre of pins . . .		25000		Bending.
	Extreme fibre of purlins . .		15000	(49)	

20. Lateral connections will have 25 per cent greater unit strains than above. Laterals.

21. Bolts may be used for field connections at two-thirds of rivet values. (17, 18.) Bolts.

TIMBER PURLINS

22. In purlins of yellow pine, southern pine or white oak, the extreme fibre strain shall not exceed 1200 lbs. sq. in. (50) Timber.

PLATE GIRDERS.

23. The length of span shall be considered as the distance from center to center of end bearings when girders rest on bottom flange, and from end to end when fastened between columns by connection angles. Girders.

24. The compression flanges shall be stayed transversely when their length is more than thirty times their width. (15) Flanges.

One-sixth of the web shall be included as flange area, provided proper horizontal splices are made at web joints.

25. All web plates shall be stiffened at the inner and outer edges of the end bearings and at all points of local concentrated loading. Stiffeners.

Intermediate stiffeners shall be used provided the shearing strain per square inch exceeds that given by the formula:

$$\frac{15000}{1 + \frac{d^2}{3000t^2}}$$

d = Clear dist. between flange angles in inches.

t = Thickness of web in inches.

CORRUGATED IRON COVERING.

26. Corrugated iron shall generally be of 2½ inch corrugations, and the gage in U. S. standard shall be shown on strain sheet. Covering.

27. The span or distance center to center of roof purlins shall not exceed that given in the following table:

27 gage . . .	2′—0″	20 gage . . .	4′—6″
26 gage . . .	2′—6″	18 gage . . .	5′—0″
24 gage . . .	3′—0″	16 gage . . .	5′—6″
22 gage . . .	4′—0″		

(48)

28. All corrugated iron shall be laid with one corrugation side lap, and not less than four inches end lap, generally with six inches end lap. (32)

Valleys

29. All valleys or junctions shall have flashing extending at least 12 inches under the corrugated iron, or 12 inches above line where water will stand. (35, 36.)

Ridges

30. All ridges shall have roll cap securely fastened over the corrugated iron.

Fastenings

31. Corrugated iron shall preferably be secured to the purlin by galvanized straps of not less than five-eighths of an inch wide by No. 18 gage; these shall pass completely around the purlin, and have each end riveted to the sheet. There shall be at least two fastenings on each purlin for each sheet.

32. The side laps shall be riveted with six pound rivets not more than six inches apart. (28.)

Finish Angle

33. At the gable ends the corrugated iron shall be securely fastened down on the roof, to a finish angle or channel, connected to the end of the roof purlins.

VENTILATORS AND LOUVRES.

Ventilators

34. Ventilators shall be provided and located so as to properly ventilate the building. They shall have a net area of openings for each 100 square feet of floor surface of not less than one-half a square foot for machine shops, of not less than five square feet for mill buildings and not less than seven square feet for forge shops.

Louvres

Louvres shall be provided in ventilators, if necessary, of such form as to prevent the blowing in of snow or storm water, and of a stiff enough section not to sag below hoizontal and appear unsightly. They shall be not less than No. 16 gage galvanized for flat louvres, and No. 20 gage galvanized for corrugated louvres.

LIGHTING.

Windows

35. Windows shall be provided in the sides and clearstory or ventilator of a surface equal to not less than 10 per cent of the entire exterior surface of the buildings, in mill buildings, and of not less than 20 per cent in machine shops or similiar buildings. (29)

Skylights

36. At least half of the lighting specified shall preferably be in the form of skylights of some form of construction which shall entirely prohibit leaking. (29)

DETAILS OF CONSTRUCTION.

37. All tension members shall preferably be composed of angles or shapes with the object of stiffness. **Tension Members.**

38. All joints shall have full splices and not rely on gussets. (65.)

39. All main members shall preferably be made of two angles, back to back, two angles and one plate, or four angles laced. (67.)

40. Secondary members shall preferably be made of symmetrical sections.

41. Long laterals or sway rods may be made of bar, with sleeve nut adjustment, to facilitate erection.

42. Members having such a length as to cause them to sag shall be held up by sag ties of angles, properly spaced.

43. Rafters shall preferably be made of two angles, two angles and one plate, or of such form as to allow of easy connection for web members. (65.) **Compression Members.**

44. All other compression members, except sub-struts, shall be composed of sections symmetrically disposed. (65.)

45. Sub-struts shall preferably be made of symmetrical sections.

46. The trusses shall be spaced, if possible, at such distances apart as to allow of single pieces of shape iron being used for purlins, trussed purlins being avoided, if possible. Purlins shall preferably be composed of single angles, with the long leg vertical and the back toward the peak of the roof. **Purlins.**

47. Purlins shall be attached to the rafters or columns by clips, with at least two rivets in rafter and two holes for each end of each purlin.

48. Roof purlins shall be spaced at distances apart not to exceed the span given under the head of Corrugated Iron. (27.)

49. Purlins extending in one piece over two or more panels, laid to break joint, and riveted at ends, may be figured as continuous.

50. Timber purlins, if used, shall be attached in the same manner as steel purlins.

51. Sway bracing shall be introduced at such points as is necessary to insure ease of erection and sufficient transverse and longitudinal strength. (41.) **Sway Bracing**

52. All such strains shall preferably be carried to the foundation direct, but may be accounted for by bending in the columns. (62.)

53. Bed plates shall never be less thar one-half inch in thickness, and shall be of sufficient thickness and size so that the pressure on masonry will not exceed 300 pounds per square inch. Trusses over 75 feet span on walls or masonry shall have expansion rollers if necessary. (54.) **Bed Plates.**

Anchor Bolts. 54. Each bearing plate shall be provided with two anchor bolts of not less than three-fourths of an inch in diameter, either built into the masonry or extending far enough into the masonry to make them effective. (53.)

Punching. 55. The diameter of the punch shall not exceed the diamter of the rivet, nor the diameter of the die exceed the diameter of the punch by more than one-sixteenth of an inch. (56.)

Punching and Reaming. 56. All rivet holes in steel may be punched, and in case holes do not match in assembled members they shall be reamed out with power reamers. (71.)

Effective Diameter of Rivets. 57. The effective diameter of the driven rivet shall be assumed the same as before driving, and in making deductions for rivet holes in tension members, the hole will be assumed one eighth of an inch larger than the undriven rivet. (13,17.)

Pitch of Rivets. 58. The pitch of rivets shall not exceed twenty times the thickness of the plate in the line of strain, nor forty times the thickness at right angles to the line of strain. It shall never be less than three diameters of the rivet. At the ends of compression members it shall not exceed four diameters of the rivet for a length equal to the width of the members.

Length of Compression Members. 59. No compression member shall have a length exceeding fifty times its least width, unless its unit strain is reduced accordingly. (14.)

Tie Plates. 60. Laced compression members shall be stayed at the ends by batten plates having a length not less than the depth of the member.

Lacing Bars. 61. The sizes of lacing bars shall not be less than that given in the following table, when the distance between the gage lines is— (62.)

6″ or less than 8″ . . .	1 1-4″ x 1-4″
8″ or less than 10″ . . .	1 1-2″ x 1-4″
10″ or less than 12″ . . .	1 3-4″ x 5-16″
12″ or less than 16″ . . .	2″ x 3-8″
16″ or less than 20″ . . .	2 1-4″ x 7-16″
20″ or less than 24″ . . .	2 1-2″ x 1-2″
24″ or above of angles.	

They shall generally be inclined at 45 degress to the axis of the member, but shall not be spaced so as to reduce the strength of the member as a whole.

Bending. 62. Where laced members are subjected to bending, the size of lacing bars or angles shall be calculated or a solid web plate used. (13, 14, 61.)

Upset Rods. 63. All rods having screw ends shall be upset to standard size, or have due allowance made.

Variation in Weight 64. No metal of less thickness than 1/4 inch shall be used, except as fillers, and no angles of less than 2 inch leg. A variation of 3 per cent shall be allowable in the weight or cross section of material.

WORKMANSHIP.

65. All workmanship shall be first class in every particular. All abutting surfaces of compression members, except where the joints are fully spliced, must be planed to even bearing so as to give close contact throughout. (38.) Finished Surfaces.

66. All planed or turned surfaces left exposed must be protected by white lead and tallow. (89)

67. Rivet holes for splices must be so accurately spaced that the holes will come exactly opposite when the members are brought into position for driving rivets, or else reamed out. (38, 70, 71.) Rivets

68. Rivets must completely fill the holes and have full heads concentric with the rivet holes. They shall have full contact with the surface, or be countersunk when so required, and shall be machine driven when possible. Rivets must not be used in direct tension.

69. Built members when finished must be free from twists, open joints or other defects. (65.)

70. Drift pins must only be used for bringing the pieces together, and they must not be driven so hard as to distort the metal. (71.) Drilling.

71. When holes need enlarging, it must be done by reaming and not by drifting. (70.) Reaming.

72. The decision of the engineer or architect shall control as as to the interpretation of the drawings and specifications during the progress of the work. But this shall not deprive the contractor of right of redress after work is completed, if the decision shall be proven wrong. (1, 91, 95.) Drawings and Specificat'ns.

QUALITY OF MATERIAL.

WROUGHT IRON

73. All wrought iron must be tough, ductile, fibrous and of uniform quality. Finished bars must be thoroughly welded during the rolling, and be straight, smooth and free from injurious seams, blisters, buckles, cracks or imperfect edges. Character and Finish.

74. No one process of manufacture is preferred over another, provided the material complies with this specification. Manufacture.

75. For tension tests the test piece shall have as near one-half square inch of sectional area as possible, and a length of at least 8 inches with uniform section, for determining the elongation. Standard Test Pieces.

76. The elastic limit shall be not less than 26,000 pounds per square inch for all classes of iron. Elastic Limit.

77. Standard test pieces from iron having a section of 4½ square inches or less shall show an ultimate strength of not less than 50,000 pounds per square inch and an elongation in 8 inches of not less than 18 per cent. Tension Iron

78. Standard test pieces from bars of more than 4½ square inches section will be allowed a reduction of 500 pounds for each additional square inch of section, provided the ultimate strength does not fall below 48,000 pounds or the elongation in 8 inches below 15 per cent.

79. All iron for tension members must bend cold through 90 degrees to a curve whose diameter is not over twice the thickness of the piece, without cracking.

80. Not less than one sample out of three shall bend cold to this curve through 180 degrees, without cracking.

81. When nicked on one side and bent by a blow from a sledge, the fracture must be wholly fibrous.

STEEL.

Manufacture. 82. Steel made either by the Bessemer or Open Hearth process of manufacture shall be acceptable.

Standard Test Pieces. 83. Test pieces for tension and bending tests shall have as near one-half square inch of sectional area as possible and a length of at least 8 inches with uniform section, for determiming elongation.

84. One test piece for tension and one for bending are to be taken from each heat or blow of finished material.

Finish. 85. Finished bars must be free from flaws, cracks or injurious seams and have a first-class finish.

Grades of Steel. 86. Steel of soft and soft-medium grades only are to be used, the soft steel for rivets and offset or bent angles or plates, and soft-medium for all other parts where iron is not optional.
Phosphorus and Sulphur Limit. The phosphorus shall never exceed in any steel 0.08 per cent., nor the sulphur 0.04 per cent. (56.)

Soft Steel. 87. Standard test pieces of finished material shall have an ultimate strength of from 50,000 to 60,000 pounds per square inch; an elastic limit of one-half the ultimate strength; an elongation in 8 inches of not less than 25 per cent; and a reduction of area at fracture of not less than 50 per cent. Samples to bend cold 180 degrees flat on itself, without sign of fracture on the outside bent portion.

Soft-Medium Steel. 88. Standard test pieces of finished material shall have an ultimate strength of from 55,000 to 65,000 pounds per square inch; elastic limit not less than one-half the ultimate strength; an elongation in 8 inches of not less than 25 per cent.; and a reduction of area at fracture of not less than 50 per cent. Samples to bend cold 180 degrees to a diameter equal to the thickness of the sample without crack or flaw on fhe outside of the bent portion.

PAINTING.

Painting. 89. All iron or steel framing and all corrugated iron, unless galvanized, shall have one coat of pure lead paint before leaving the shop; all surfaces in contact shall have one heavy

coat of pure lead paint before assembling, and all planed or turned surfaces shall be coated with white lead and tallow (66.)

90. Parts difficult of access after erectiion shall have two coats of pure lead paint at the shop.

91. After erection all the work except galvanized iron shall receive one coat of pure lead paint of such shade as the engineer or architect may select, and it shall be thoroughly and evenly applied. (72,95.)

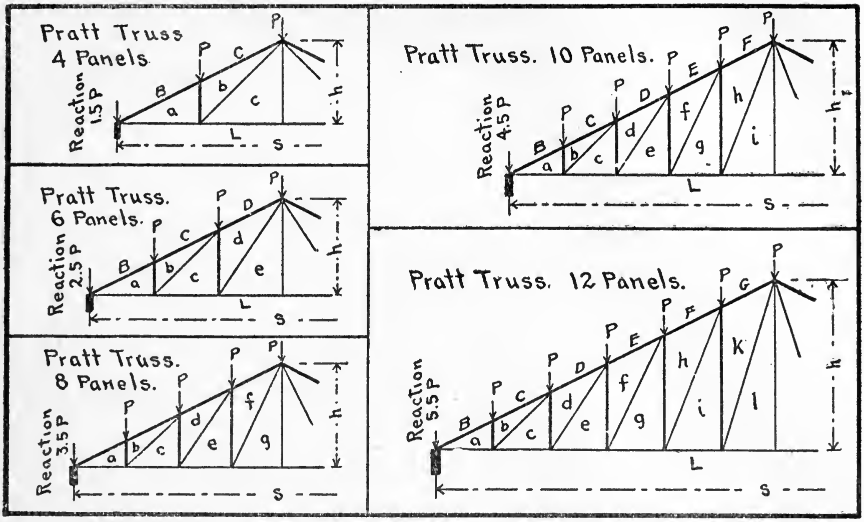
ERECTION.

92. The contractor will furnish all tools, derricks or staging and material of every description for the erection of the whole or such portions of the work as are included in the contract, and remove the same when the work is completed, leaving the premises as free from rubbish or obstruction as when the erection was commenced. **Erection.**

93. The contractor shall assume all risks from storms or accidents to the work, unless caused by the negligence or interference of the owner or his employees; also all damage to persons and properties and casualties of every description, until the final acceptance of the completed structure.

94. The contractor shall comply with all ordinances or regulations of the authorities having jurisdiction over the premises or abutting premises.

95. The erection is to be carried on subject to the approval and inspection of the engineer or architect, and it is to be completed to his satisfaction and in full accordance with the contract. (72,91.)



s=span. h=height. P= panel load. $n = \frac{s}{h} = \frac{1}{\text{pitch}}$

+compression. —tension. Strain in member = P×coefficient.

Load on wall or column= Reaction+0.5P.

PRATT TRUSS, EIGHT PANELS.

Member	$n=3$	$n=4$	$n=5$	General Formulæ.	
Ba-Cb	6.31	7.83	9.42	$+1.75\sqrt{n^2+4}$	×P
Dd	5.41	6.71	8.08	$+1.50\sqrt{n^2+4}$	×P
Ef	4.51	5.59	6.73	$+1.25\sqrt{n^2+4}$	×P
La	5.25	7.00	8.75	$-1.75\,n$	×P
Lc	4.50	6.00	7.50	$-1.50\,n$	×P
Le	3.75	5.00	6.25	$-1.25\,n$	×P
Lg	3.00	4.00	5.00	$-1.00\,n$	×P
ab	1.00	1.00	1.00	$+1.00$	×P
cd	1.50	1.50	1.50	$+1.50$	×P
ef	2.00	2.00	2.00	$+2.00$	×P
bc	1.25	1.41	1.60	$-0.25\sqrt{n^2+16}$	×P
de	1.68	1.80	1.95	$-0.25\sqrt{n^2+36}$	×P
fg	2.14	2.24	2.36	$-0.25\sqrt{n^2+64}$	×P

Member	$n=3$	$n=4$	$n=5$	General Formulæ.	
Ba-Cb	2.70	3.35	4.04	$+0.75\sqrt{n^2+4}$	$\times P$
La	2.25	3.00	3.75	$-0.75\,n$	$\times P$
Lc	1.50	2.00	2.50	$-0.50\,n$	$\times P$
ab	1.00	1.00	1.00	$+1.00$	$\times P$
bc	1.25	1.41	1.60	$-0.25\sqrt{n^2+16}$	$\times P$

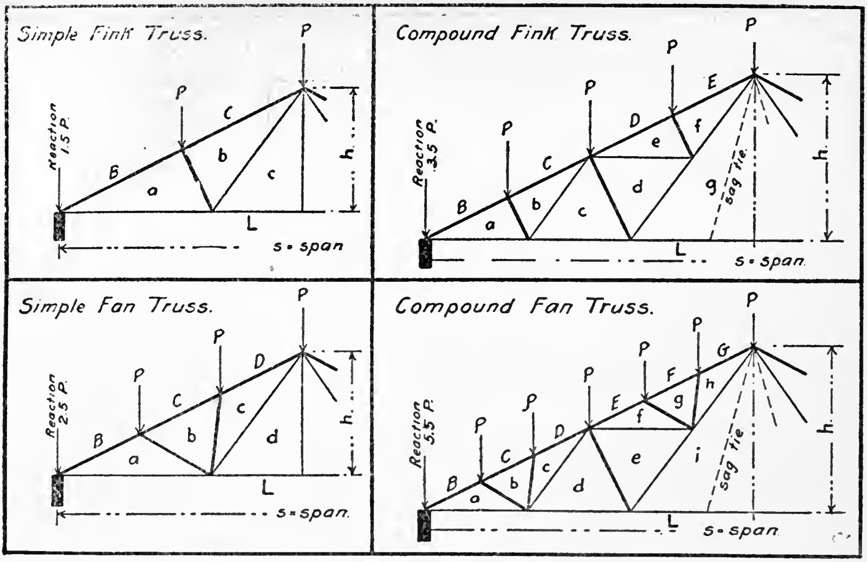
PRATT TRUSS, TWELVE PANELS.

Member	$n=3$	$n=4$	$n=5$	General Formulæ.	
Ba·Cb	9.92	12.30	14.81	$+2.75\sqrt{n^2+4}$	$\times P$
Dd	9.01	11.18	13.46	$+2.50\sqrt{n^2+4}$	$\times P$
Ef	8.11	10.06	12.12	$+2.25\sqrt{n^2+4}$	$\times P$
Fh	7.21	8.94	10.77	$+2.00\sqrt{n^2+4}$	$\times P$
Gk	6.31	7.83	9.42	$+1.75\sqrt{n^2+4}$	$\times P$
La	8.25	11.00	13.75	$-2.75n$	$\times P$
Lc	7.50	10.00	12.50	$-2.50n$	$\times P$
Le	6.75	9.00	11.25	$-2.25n$	$\times P$
Lg	6.00	8.00	10.00	$-2.00n$	$\times P$
Li	5.25	7.00	8.75	$-1.75n$	$\times P$
Ll	4.50	6.00	7.50	$-1.50n$	$\times P$
ab	1.00	1.00	1.00	$+1.00$	$\times P$
cd	1.50	1.50	1.50	$+1.50$	$\times P$
ef	2.00	2.00	2.00	$+2.00$	$\times P$
gh	2.50	2.50	2.50	$+2.50$	$\times P$
ik	3.00	3.00	3 00	$+3.00$	$\times P$
bc	1.25	1.41	1.60	$-0.25\sqrt{n^2+16}$	$\times P$
de	1.68	1.80	1.95	$-0.25\sqrt{n^2+36}$	$\times P$
fg	2.14	2.24	2.36	$-0\ 25\sqrt{n^2+64}$	$\times P$
hi	2.61	2.69	2.80	$-0.25\sqrt{n^2+100}$	$\times P$
kl	3.09	3.16	3.25	$-0.25\sqrt{n^2+144}$	$\times P$

Member	$n=3$	$n=4$	$n=5$	General Formulæ.	
Ba-Cb	4.51	5.59	6.73	$+1.25\sqrt{n^2+4}$	$\times P$
Dd	3.61	4.47	5.39	$+1.00\sqrt{n^2+4}$	$\times P$
La	3.75	5.00	6.25	$-1.25\,n$	$\times P$
Lc	3.00	4.00	5.00	$-1.00\,n$	$\times P$
Le	2.25	3.00	3.75	$-0.75\,n$	$\times P$
ab	1.00	1.00	1.00	$+1.00$	$\times P$
cd	1.50	1.50	1.50	$+1.50$	$\times P$
bc	1.25	1.41	1.60	$-0.25\sqrt{n^2+16}$	$\times P$
de	1.68	1.80	1.95	$-0.25\sqrt{n^2+36}$	$\times P$

PRATT TRUSS, TEN PANELS.

Member	$n=3$	$n=4$	$n=5$	General Formulæ.	
Ba-Cb	8.11	10.06	12.12	$+2.25\sqrt{n^2+4}$	$\times P$
Dd	7.21	8.94	10.77	$+2.00\sqrt{n^2+4}$	$\times P$
Ef	6.31	7.83	9.42	$+1.75\sqrt{n^2+4}$	$\times P$
Fh	5.41	6.71	8.08	$+1.50\sqrt{n^2+4}$	$\times P$
La	6.75	9.00	11.25	$-2.25n$	$\times P$
Lc	6.00	8.00	10.00	$-2.00n$	$\times P$
Le	5.25	7.00	8.75	$-1.75n$	$\times P$
Lg	4.50	6.00	7.50	$-1.50n$	$\times P$
Li	3.75	5.00	6.25	$-1.25n$	$\times P$
ab	1.00	1.00	1.00	$+1.00$	$\times P$
cd	1.50	1.50	1.50	$+1.50$	$\times P$
ef	2.00	2.00	2.00	$+2.00$	$\times P$
gh	2.50	2.50	2.50	$+2.50$	$\times P$
bc	1.25	1.41	1.60	$-0.25\sqrt{n^2+16}$	$\times P$
de	1.68	1.80	1.95	$-0.25\sqrt{n^2+36}$	$\times P$
fg	2.14	2.24	2.36	$-0.25\sqrt{n^2+64}$	$\times P$
hi	2.61	2.69	2.80	$-0.25\sqrt{n^2+100}$	$\times P$



s = span. h = height. P = panel load. $n = \frac{s}{h} = \frac{1}{\text{pitch}}$ + compression. — tension.
Strain in member = P × coefficient. Load on wall or column = Reaction + 0.5 P

COMPOUND FINK TRUSS.

Member.	$n=3$	$n=4$	$n=5$	General Formulæ.	
Ba	6.31	7.83	9.42	$+\frac{7}{4}\sqrt{n^2+4}$	× P
La	5.25	7.00	8.75	$-\frac{7}{4}n$	× P
ab	0.83	0.89	0.93	$+\frac{n}{\sqrt{n^2+4}}$	× P
Cb	5.76	7.38	9.05	$+\frac{1}{\sqrt{n^2+4}}\left(\frac{7}{4}n^2+5\right)$	× P
bc	0.75	1.00	1.25	$-\frac{1}{4}n$	× P
Lc	4.50	6.00	7.50	$-\frac{3}{2}n$	× P
cd	1.66	1.79	1.86	$+\frac{2n}{\sqrt{n^2+4}}$	× P
De	5.20	6.93	8.68	$+\frac{1}{\sqrt{n^2+4}}\left(\frac{7}{4}n^2+3\right)$	× P
ed	0.75	1.00	1.25	$-\frac{1}{4}n$	× P
Lg	3.00	4.00	5.00	$-\ n$	× P
dg	1.50	2.00	2.50	$-\frac{1}{2}n$	× P
ef	0.83	0.89	0.93	$+\frac{n}{\sqrt{n^2+4}}$	× P
fg	2.25	3.00	3.75	$-\frac{3}{4}n$	× P
Ef	4.65	6.48	8.31	$+\frac{1}{\sqrt{n^2+4}}\left(\frac{7}{4}n^2+1\right)$	× P

Member.	$n=3$	$n=4$	$n=5$	General Formulæ.
Ba	2.71	3.35	4.04	$+\frac{3}{4}\sqrt{n^2+4} \quad \times P$
La	2.25	3.00	3.75	$-\frac{3}{4}n \quad \times P$
ab	0.83	0.89	0.93	$+\frac{n}{\sqrt{n^2+4}} \quad \times P$
Cb	2.15	2.91	3.66	$+\frac{1}{\sqrt{n^2+4}}(\frac{3}{4}n^2+1) \quad \times P$
bc	0.75	1.00	1.25	$-\frac{1}{4}n \quad \times P$
Lc	1.50	2.00	2.50	$-\frac{1}{2}n \quad \times P$

COMPOUND FAN TRUSS.

Member.	$n=3$	$n=4$	$n=5$	General Formulæ.
Ba	9.91	12.30	14.80	$+\frac{1}{\sqrt{n^2+4}}(\frac{11}{4}n^2+11) \quad \times P$
La	8.25	11.00	13.75	$-\frac{11}{4}n \quad \times P$
ab–bc	0.93	1.08	1.21	$+\frac{n\sqrt{n^4+40n^2+144}}{6(n^2+4)} \quad \times P$
Cb	8.94	11.25	13.66	$+\frac{1}{\sqrt{n^2+4}}(\frac{31}{12}n^2+9) \quad \times P$
Dc	8.80	11.40	14.07	$+\frac{1}{\sqrt{n^2+4}}(\frac{11}{4}n^2+7) \quad \times P$
cd	1.50	2.00	2.50	$-\frac{1}{2}n \quad \times P$
Ld	6.75	9.00	11.25	$-\frac{9}{4}n \quad \times P$
de	2.50	2.69	2.79	$+\frac{3n}{\sqrt{n^2+4}} \quad \times P$
Ef	8.25	10.96	13.69	$+\frac{1}{\sqrt{n^2+4}}(\frac{11}{4}n^2+5) \quad \times P$
fe	1.50	2.00	2.50	$-\frac{1}{2}n \quad \times P$
ei	2.25	3.00	3.75	$-\frac{3}{4}n \quad \times P$
Li	4.50	6.00	7.50	$-\frac{3}{2}n \quad \times P$
fg–gh	0.93	1.08	1.21	$+\frac{n\sqrt{n^4+40n^2+144}}{6(n^2+4)} \quad \times P$
Fg	7.28	9.93	12.54	$+\frac{1}{\sqrt{n^2+4}}(\frac{31}{12}n^2+3) \quad \times P$
Gh	7.14	10.06	12.95	$+\frac{1}{\sqrt{n^2+4}}(\frac{11}{4}n^2+1) \quad \times P$
hi	3.75	5.00	6.25	$-\frac{5}{4}n \quad \times P$

SIMPLE FAN TRUSS.

Member.	$n=3$	$n=4$	$n=5$	General Formulæ.	
Ba	4.50	5.59	6.73	$+\frac{1}{\sqrt{n^2+4}}(\frac{5}{4}n^2+5)$	$\times P$
La	3.75	5.00	6.25	$-\frac{5}{4}n$	$\times P$
ab, bc	0.93	1.08	1.21	$+\frac{n\sqrt{n^4+40n^2+144}}{6(n^2+4)}$	$\times P$
Cb	3.53	4.55	5.58	$+\frac{1}{2\sqrt{n^2+4}}(\frac{13}{6}n^2+6)$	$\times P$
Dc	3.39	4.70	5.98	$+\frac{1}{\sqrt{n^2+4}}(\frac{5}{4}n^2+1)$	$\times P$
cd	1.50	2.00	2.50	$-\frac{1}{2}n$	$\times P$
Ld	2.25	3.00	3.75	$-\frac{3}{4}n$	$\times P$

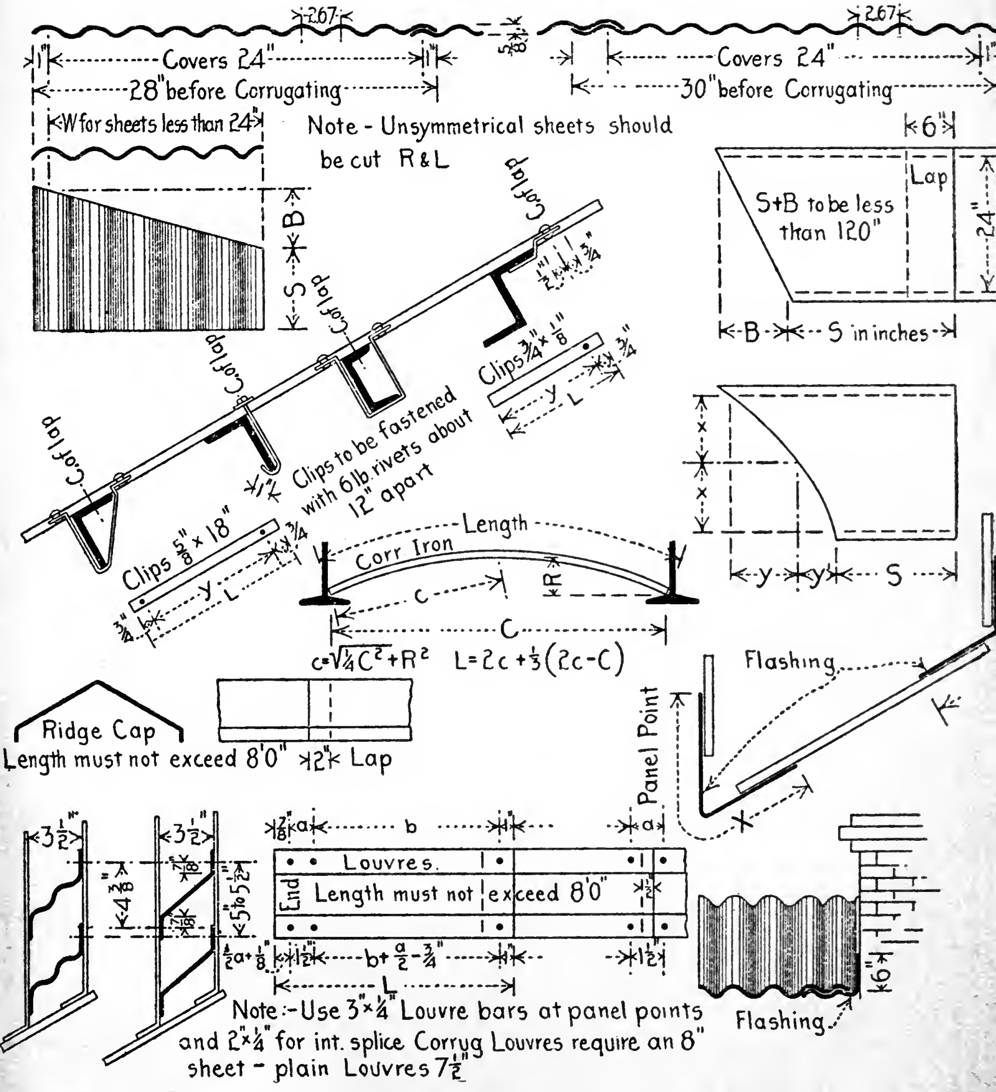
STEEL COLUMN UNIT STRAINS. ☐ ☐ $12500 - 500\frac{l}{r}$

$l \div r$	☐ ☐	$l \div r$	☐ ☐	$l \div r$	☐ ☐	$l \div r$	☐ ☐
3.0	11000	7.6	8700	12.2	6400	16.8	4100
.2	10900	.8	8600	.4	6300	17.0	4000
.4	10800	8.0	8500	.6	6200	.2	3900
.6	10700	.2	8400	.8	6100	.4	3800
.8	10600	.4	8300	13.0	6000	.6	3700
4.0	10500	.6	8200	.2	5900	.8	3600
.2	10400	.8	8100	.4	5800	18.0	3500
.4	10300	9.0	8000	.6	5700	.2	3400
.6	10200	.2	7900	.8	5600	.4	3300
.8	10100	.4	7800	14.0	5500	.6	3200
5.0	10000	.6	7700	.2	5400	.8	3100
.2	9900	.8	7600	.4	5300	19.0	3000
.4	9800	10.0	7500	.6	5200	2	2900
.6	9700	.2	7400	.8	5100	.4	2800
.8	9600	.4	7300	15.0	5000	.6	2700
6.0	9500	.6	7200	.2	4900	.8	2600
.2	9400	.8	7100	.4	4800	20.0	2500
.4	9300	11.0	7000	.6	4700	.2	2400
.6	9200	.2	6900	.8	4600	.4	2300
8	9100	.4	6800	16.0	4500	.6	2200
7.0	9000	.6	6700	.2	4400	.8	2100
.2	8900	.8	6600	.4	4300		
.4	8800	12.0	6500	.6	4200		

SHEARING AND BEARING VALUE OF RIVETS.

Diam. of Rivet in inches.		Area of Rivet.	Single Shear at 10000 lb pr sq in	Bearing val. of different thicknesses of plate at 20000 lbs. per sq. in. (= Diam. of Rivet X thickness of plate X 20000 lbs.							
Fraction.	Decimal.			$\frac{1}{4}''$	$\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{7}{16}''$	$\frac{1}{2}''$	$\frac{9}{16}''$	$\frac{5}{8}''$	$\frac{11}{16}''$
$\frac{1}{2}''$	.5	.1963	1960	2500	3130	3750					
$\frac{9}{16}''$	.5625	-2485	2480	2810	3520	4210	4920				
$\frac{5}{8}''$	.625	.3068	3070	3130	3910	4690	5470				
$\frac{11}{16}''$	.6875	.3712	3710	8440	4290	5160	6010	6880			
$\frac{3}{4}''$	.75	.4418	4420	3750	4690	5630	6560	7500	8440		
$\frac{13}{16}''$	8125	.5185	5180	4070	5080	6090	7110	8120	9150	10160	
$\frac{7}{8}''$	.875	.6013	6010	4380	5470	6570	7660	8750	9840	10940	
$\frac{15}{16}''$	.9375	.6903	6900	4690	5850	7030	8200	9370	10550	11720	12890

INDEX.



CORRUGATED IRON, LOUVRES, FLASHING &c.